Lumicyano: a one-step fluorescent cyanoacrylate technique

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Introduction

Cyanoacrylate (superglue) is a routine enhancement technique for the development of latent fingermarks on non-porous surfaces. The articles under examination are fumed with cyanoacrylate by heating it to about 120^{o}C in a cabinet with a relative humidity of 80%. As certain components of a latent fingermark residue come into contact with the cyanoacrylate vapour, a polymerisation reaction occurs along the ridges to produce a white polymer. The contrast between the developed cyanoacrylate polymer on the fingermark ridges and the substrate may be poor, so subsequent powdering or staining with a fluorescent dye is generally necessary. This is the basis of a two-step cyanoacrylate method where the articles to be examined are first fumed with cyanoacrylate then treated with a fluorescent dye such as basic yellow 40 (BY40). The cyanoacrylate polymer produced under these conditions has a noodle-like structure that allows for efficient light scattering and visualisation in addition to trapping of fluorescent dyes molecules for successful staining and observation of fluorescence.

One-step fluorescent cyanoacrylate

A one-step fluorescent cyanoacrylate process involves the use of a product that has a fluorescent dye (fluorophore) incorporated into the cyanoacrylate. The one-step products are more expensive to purchase in comparison to the traditional two-step products but can reduce overall costs as casework can be processed more quickly (no dyeing and drying time) and there is no requirement for a dye tank and drying space. The use of a liquid dyeing procedure on semi-porous surfaces may result in excessive background staining and may interfere with subsequent DNA analysis. Over the last few years, there have been a number of commercial products marketed as a one-step fluorescent cyanoacrylate process e.g. Polycyano (Cyano UV, Foster and Freeman, U.K.), Lumicyano (Crime Scene Technology, France), PECA Multiband (BVDA), Fuming Orange and CN Yellow (Aneval, Inc., IL). For such products, fluorescence examination should be performed as soon as possible after fuming since their fluorescence is known to decay over time, limiting the potential of such products in comparison to a two-step process. A number of these products require a temperature of 230^{o}C; however, heating cyanoacrylates to these temperatures may result in the production of hydrogen cyanide gas.

Lumicyano

Researchers at Abertay University have carried out a number of trials using Lumicyano. Lumicyano is currently the only one-step fluorescent cyanoacrylate product that requires a heating temperature of 120^{o}C rather than 230^{o}C. The developers of this product report that it is excited with UV or blue/green light (figure 1) and offers equal or better sensitivity to the two-step process. A pseudo-operational trial on polyethylene bags using a Lumicyano dye concentration of 1%, two-step cyanoacrylate/BY40 and iron-oxide powder suspension reported a similar number of detected marks by these techniques; however, the use of BY40 after Lumicyano provided an additional 15% detection rate. In this trial, it was noted that the fluorescence decayed rapidly and completely after 1 week, even more so when the substrates were stored in daylight conditions. The manufacturer later recommended an increase in the dye concentration to 4, 5, 8 and even 10%, which decreases the rate of fluorescence decay. A higher concentration of 4% showed that the fluorescence lasted for at least 4 weeks when stored in the dark. It is possible to restore fluoresce by re-fuming the articles under examination with Lumicyano and/or subsequent treatment with a fluorescent stain such as BY40. Further studies reported the sequential process of Lumicyano fuming at atmospheric/humidity conditions followed by an additional Lumicyano fuming cycle at the same conditions. The second fuming cycle resulted in the detection of marks that were not observed during the first cycle. A later study compared three one-step fluorescent cyanoacrylate products (Lumicyano, PolyCyano UV and PECA Multiband) and compared to the two-step process with BY40. Lumicyano and PolyCyano UV provided similar results before BY40 staining, with both providing good contrast and visibility under fluorescence. PECA Multiband, however, did not develop as many fingermarks and proved to be problematic for the fuming cabinet. Subsequent BY40 staining of fingermarks developed by all three one-step processes enabled the visualisation of new additional fingermarks.

Summary

The main advantages of Lumicyano and other one-step process are the reduction of processing times and space saving aspects. Furthermore, the absence of solvents can potentially reduce interference with subsequent DNA analysis and other forensic evidence. A major drawback is the fluorescence decay. Future work will assess the viability of Lumicyano at the crime scene. There is no doubt about the advantages of a one-step fluorescent cyanoacrylate process; however, extensive further research and validation is required by the forensic community.

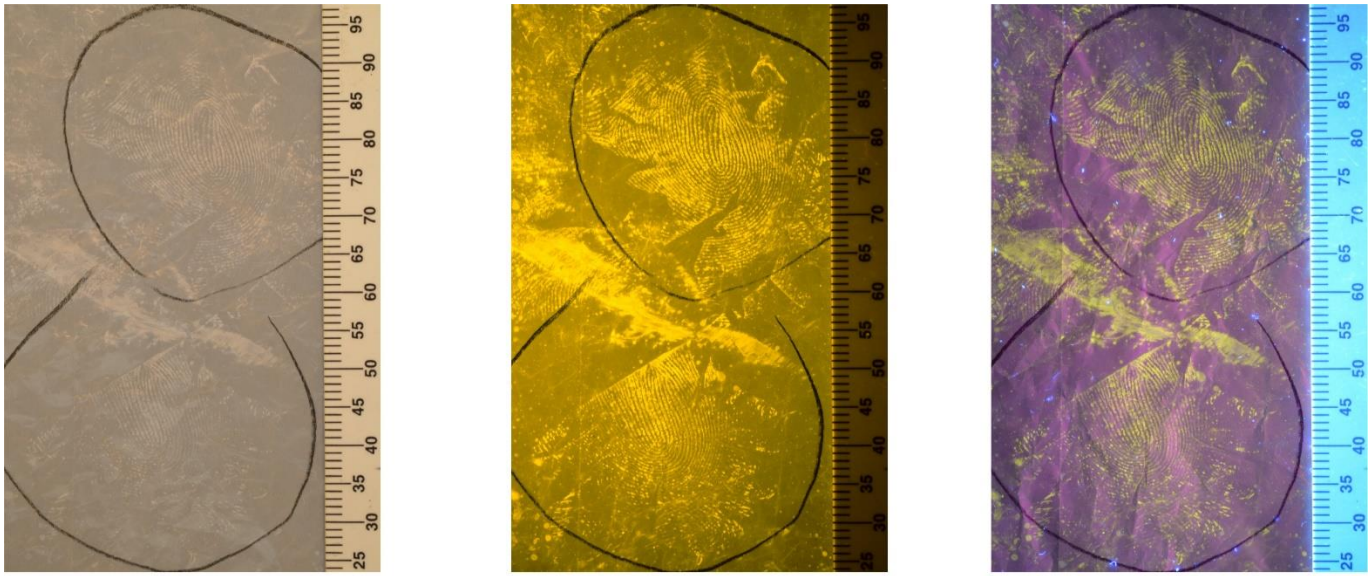

Figure 1 - Fingermarks on a plastic bag after development with 4% Lumicyano and observed under (a) white light; (b) blue-green light (orange filter); (c) UV light (clear UV filter).

Abertay peer-reviewed publications investigating Lumicyano

[1] K.J. Farrugia, P. Deacon, J. Fraser, Evaluation of Lumicyano™ cyanoacrylate fuming process for the development of latent fingermarks on plastic carrier bags by means of a pseudo operational comparative trial., Sci. Justice. 54 (2014) 126–32.

[2] K.J. Farrugia, J. Fraser, N. Calder, P. Deacon, Pseudo-Operational Trials of Lumicyano Solution and Lumicyano Powder for the Detection of Latent Fingermarks on Various Substrates, J. Forensic Identif. 64 (2014) 556–582.

[3] K.J. Farrugia, J. Fraser, L. Friel, D. Adams, N. Attard-Montalto, P. Deacon, A comparison between atmospheric/humidity and vacuum cyanoacrylate fuming of latent fingermarks, Forensic Sci. Int. 257 (2015).

[4] V. Stewart, P. Deacon, K. Farrugia, A review of one-step fluorescent cyanoacrylate techniques, Fingerpr. Whorld. 41 (2016) 6–29.